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ABSTRACT

The resource guide discusses applications of personal computers for physically disabled persons. The introductory section reviews how a severely disabled boy has learned to communicate and to play games with his able bodied friends through a personal computer. Part I details systems (such as the microcommunicator and the Handiterm) for communication. Part II reviews computer applications in two educational settings, and Part III briefly describes computer games which also enhance motor and social skills. Applications for the visually and hearing impaired are considered. Within each section are names and addresses of personal contacts for computer projects. (CL)

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ED213182

A Resource Guide

Personal Computers For The Physically Disabled

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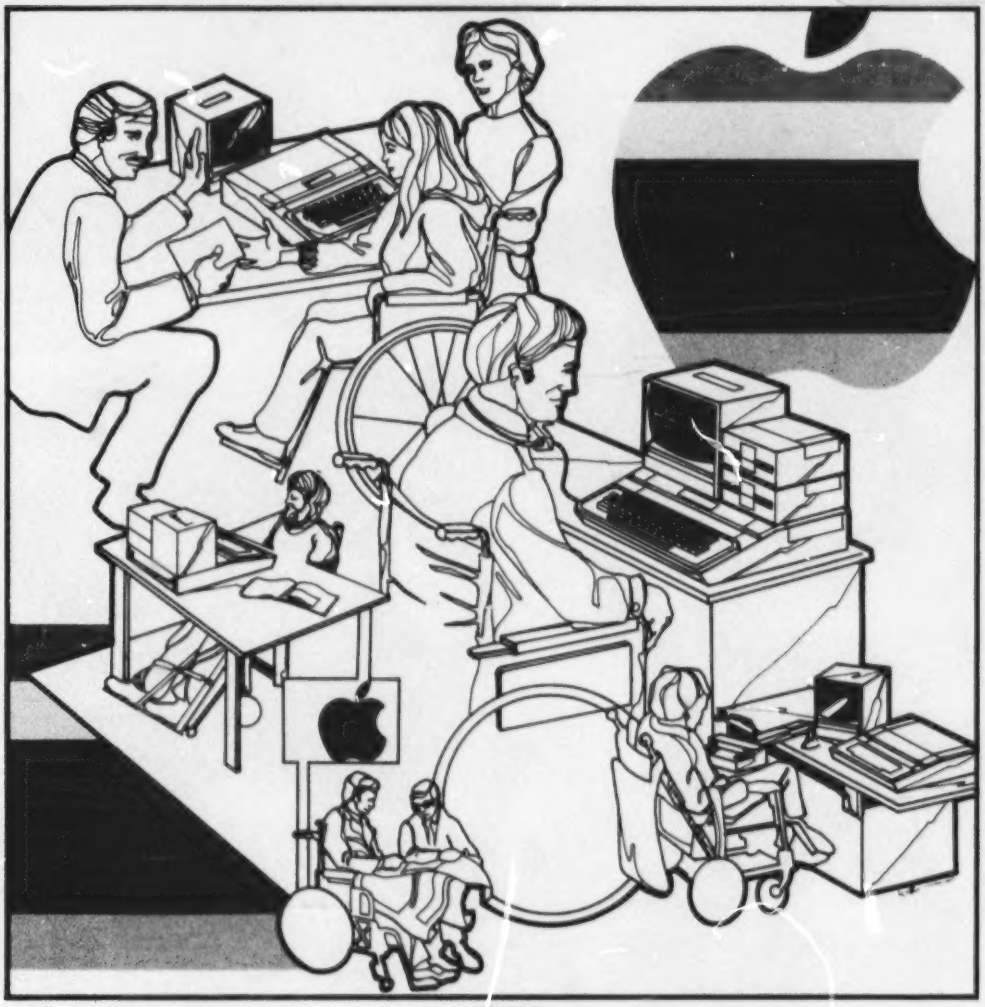

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Apple Computer Inc. has prepared this document as a public service, to stimulate research into personal computer applications for the physically disabled. Questions and inquiries should be addressed directly to the contacts listed for each application.

Personal Computers For The Physically Disabled

A Resource Guide

A group of statisticians once compared the efficiency of various animals in motion. They used the criterion: "Which species can get from point A to point B with the least amount of energy exerted?" The condor won. The human being came in about one-third of the way down the list.

But then the scientists re-rated us, this time on a bicycle. Suddenly, we were twice as efficient as the condor.

Personal computers can work the same way as the bicycle—as amplifiers of human ability.

If your hands and arms were paralyzed, a personal computer could give you a great deal of control over your environment. Using only a chin switch, you could write personal letters, business correspondence, or notes to yourself. You could store and retrieve information in your files. You could instruct your computer to look up and dial telephone numbers. When the telephone rang, you could use the computer to answer it, and to hang up afterward.

Unfortunately, an ideal computer system for the handicapped doesn't exist. But the ideas, the pieces, and the knowledge necessary to assemble such a system do. This booklet is a starting point for those who need such a tool. It brings together a range of ideas and information to help people use personal computers in applications for the physically disabled.

If you have little experience in the field, this booklet will introduce you to the potential of the personal computer. If you are already working on applications for the handicapped, this booklet provides information on the existing applications as well as a way to let others know what you are doing. Simply fill out and mail the Trace Registry Listing form on the back page of this booklet.

The systems described here are only the ones we have discovered; there are undoubtedly many more. And since many applications are still evolving, they may have been superseded by the time you read this. However, the people listed will still be useful sources of up-to-date information.

Personal computer workstations, with a myriad of applications for the handicapped, will eventually be available—but only as fast as we push for them. By using and improving the applications that exist today, we can develop the personal computer into a more powerful tool for everyone. We hope that this booklet will stimulate more people to participate in the effort.

Apple Computer Inc.

The Difference A Personal Computer Can Make

A Story

Two years ago, Hal and Mary Ann Glicksman had no experience with computers. Today, they are pioneers in the development of personal computers for the severely disabled. Motivating this work was their son John, now eight years old, who has cerebral palsy and a severe communication handicap. Here are the Glicksmans' own words about their experiences:

Our problem as parents was to find ways to communicate with John, to educate him and to create stimulating play situations that he could succeed in without frustration. We were familiar with various communication boards and mechanical devices, but all these were single-use devices. For a lower cost, we found we could buy a personal computer that would have numerous applications, and could provide varying, built-in rewards.

Our first visit to the computer store with John convinced us we were on the right track. Computers were part of the real world, not devices specially designed to overcome some specific handicap. John could reach and operate many of the buttons and joysticks from the beginning, and he felt a part of the excitement of the young people waiting to get a turn at the different computers.

We purchased an Apple II in the summer of 1978, when John was six. Once the computer was home, John would spend four or five hours on it at a stretch, even though our repertory of programs was very small at first. Within a few days he was able to directly access the keyboard with his wrist brace and the eraser end of a pencil. We are presently experimenting with a mouth stick. In the near future, we want to install a ball-bearing feeder to hold his arms, so he can type faster. John is most successful using a joystick to control the computer, since this is the way he operates his chair.

John used "BREAKOUT" (a ball and paddle game) to improve his hand/eye coordination. Although we didn't learn to program until after purchasing the Apple, we were able to successfully adapt the game to John's needs. We made the paddle longer, slowed down the ball, and added more balls to each game. John's task before playing was to design the colors for each game screen. He quickly named the colors and identified them by number. This was especially encouraging because he previously had not been willing to communicate colors or numbers consistently, and we'd worried that he had perceptual problems.

John's special education teacher has outlined many ideas for teaching phonics, shapes, spelling, days of the week, etc.

Most of these programs could also be used by a regular classroom teacher. Once again, we see the importance of using a computer instead of a device made exclusively for someone who experiences handicaps.

One of the most positive effects of having a computer in our home is that it gives John equal opportunity when playing with his able-bodied friends. John's computer is the focal point of his room, and the basis of much of his interaction with the neighborhood children. He takes turns with them playing games, and recently started to ask adults to leave him alone with his friends. This is a big step for a child who is physically handicapped.

After more than two years, using his computer is still John's favorite activity. He uses it before school and during most of the evening. As parents, we consider the personal computer to be not just a tool helping us interact with our child, but his key to a lifetime of productivity.

The Glicksmans are not working in isolation. They are trying to reach other parents, therapists, and rehabilitation professionals. They run workshops in their area to demonstrate and discuss what they're doing. At the 1980 National Computer Conference, they organized a session on "Using the Microcomputer to Overcome Disability Handicaps." They are doing this work because they believe the exchange of information from one user to another is essential to the development of the personal computer as a powerful new tool.

The Glicksmans' story illustrates some of the reasons a personal computer system can be valuable for a person with physical disabilities:

- It provides a variety of experiences, including learning, play, and communication. Those areas overlap and support each other—as when John improved his skills with colors and numbers by playing computer games.
- It allows a person with limited speech and motor control to interact easily with others.
- It can be a rewarding activity in itself.

Contacts:

Hal & Mary Ann Glicksman
619 San Juan Avenue
Venice, CA 90291
(213) 396-3301

(Excerpts were taken from articles by Hal and Mary Ann Glicksman in *Personal Computing Digest* [National Computer Conference, May, 1980] and *Communication Outlook* [February, 1980].)

Applications For The Motor And Speech Impaired

Part 1: Communications

C2E2

One of the most broadly based applications of the personal computer to date is the C2E2 (Communications, Control, Education, and Entertainment) system from the University of Alabama in Birmingham. C2E2 is usually controlled by voice commands, but it will also accept other kinds of input.

The system can be used to:

- answer and dial a telephone;
- control power, volume, and channels on a television;
- operate appliances (e.g., lights, radio, oven);
- compose, store, and type letters;
- run entertainment and educational programs;
- compose and generate music;
- interact with other computer systems over telephone lines.

The user controls the system by selecting options from a list (menu) of available functions. When the system is started up, the master control menu (figure 1) appears on the computer's TV screen (CRT). To select an option from the master menu, you simply pronounce the number of the item. To make a phone call, for example, you would first say "one," the number of the telephone control program. The computer would then display the telephone menu (figure 2). You would then say either "three" or "four," depending on the storage location of the desired phone number. (The demonstration system holds only 20 numbers, but the capability is actually unlimited.) After the call, you would hang up and return to the master control menu by saying "five." C2E2 has a similar control menu for a television set (figure 3).

When you want to write using voice control, the computer displays the alphabet in a matrix on the screen. You can enter letters into the text one at a time by speaking the row and column coordinates. The finished text can be put on one of the computer's storage disks, and/or printed out on a typewriter.

Most of the components of C2E2 are standard products. The voice input capability is provided by a "Speech Lab" device from Heuristics Inc. in Sunnyvale, California. The power switching (for controlling appliances) uses an "AC Controller" package from Mountain Computer Inc. of Santa Cruz, California. An IBM "Selecterm" typewriter with a computer-control adapter serves as the printer. And a "Micro-Modem" from D.C. Hayes Associates in Atlanta, Georgia, connects the system with other computers over a phone line. Figure 4 is a schematic of the C2E2 system.

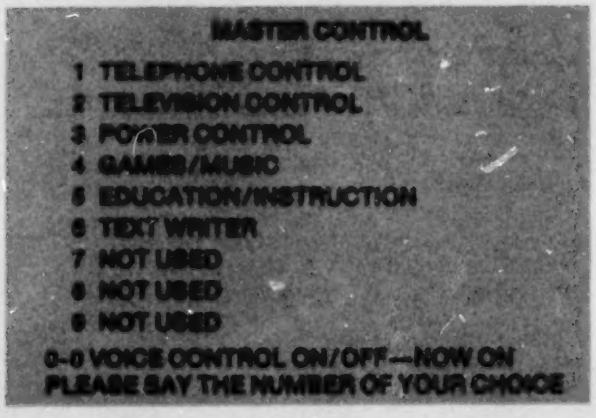

Figure 1. Master Control Menu

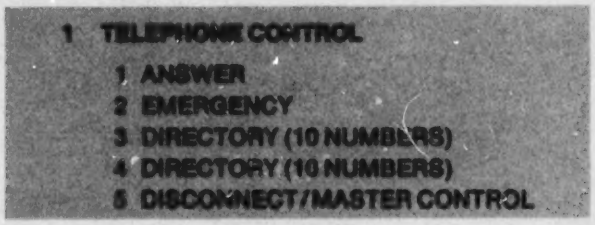

Figure 2. Telephone Control Menu

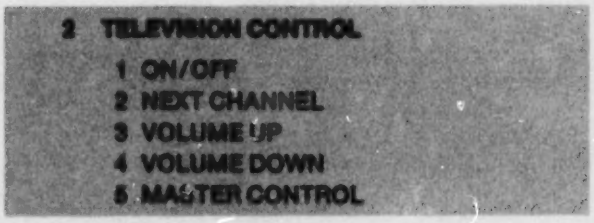

Figure 3. Television Control Menu

Contacts:

Jim Rogers
Cardiovascular Associates P.A.
1320 South 19th Street
Birmingham, AL 32505

Dr. Russ Fine
University of Alabama in Birmingham
Department of Rehabilitation Medicine
University Station
Birmingham, AL 35209

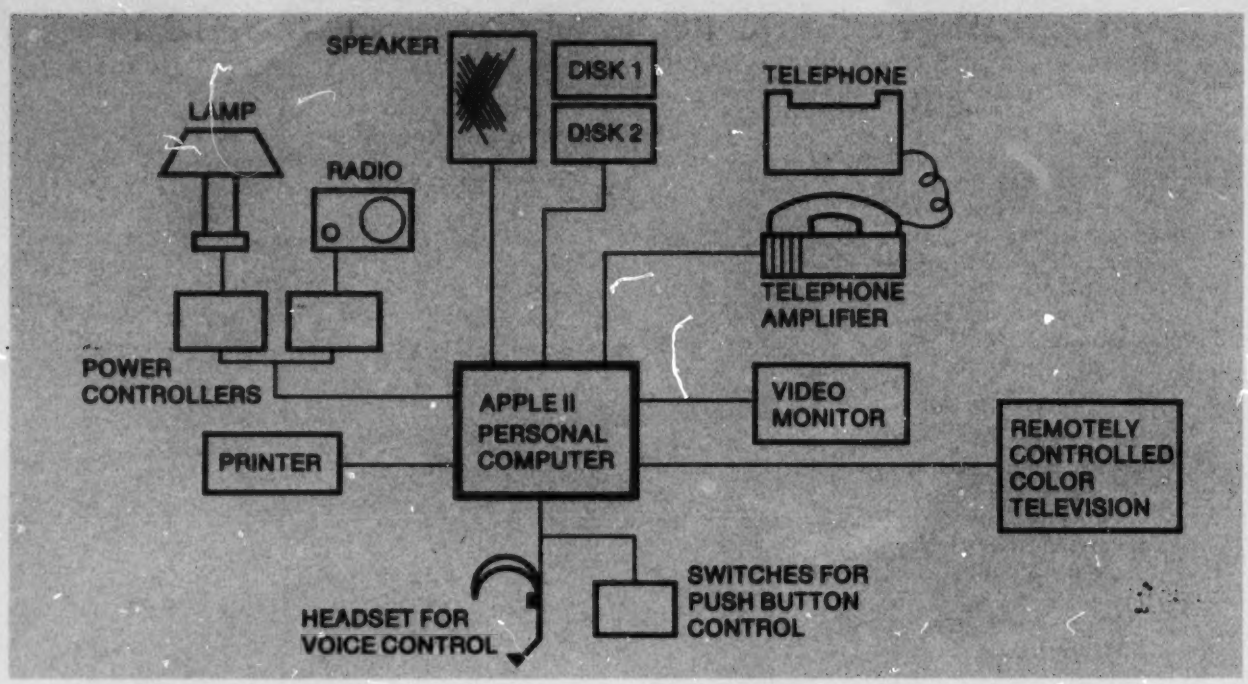

Figure 4. Block diagram of the C2E2 System.

Microcommunicator

The Microcommunicator system is a communication tool for people with some keyboard ability. The author, Grant Grover, designed the programs to minimize the number of keystrokes necessary to produce a message. Hitting a single key with a finger or mouth stick will display any of 60 sentences stored in the system. The individual user can change any of these messages. The system also allows the user to build messages up to 100 words long, using any of 1600 words in the system's vocabulary. Each word can be added to the message with only two keystrokes.

The Microcommunicator produces attention-getting sounds.

Contact:

Grover & Associates
Creekside Center, Suite D116
7 Mount Lassen Drive
San Rafael, CA 94903
(415) 479-5906

Handiterm

Handiterm is a communication system for people who cannot use a standard keyboard. The system displays a full alphabet—as well as numbers, punctuation marks, and commonly used words—on the video screen. The 80 entries are formatted in an 8-by-10 matrix. Selecting one character requires only two strokes on an oversized, 10-key board, one stroke for the column number and one for the row number of the desired character. (The keyboard must be custom built; detailed schematics and a parts list are available.) An alternative version has a scanning cursor and requires only single-switch input.

The system's primary output is text displayed on a CRT, one 80-character line at a time. If the system is equipped with a printer, it can print out text on paper. If it has a modem (a device that connects your computer and your phone), it can send messages to other computers over telephone lines. Additional accessories give the computer remote control over devices such as a television set or reading light.

(Photograph courtesy of John Giem)

Handiterm was originally built by John Giem for his son, Chris, who has cerebral palsy. Chris uses the system for communication and school work, both at home and in his classroom. John is planning to add math functions to the system, so it can be used for calculations as well as communication.

Contact:

John Giem
1904 Westfield Drive
Fort Collins, CO 80526
(303) 223-0844

Alpha Menu

Alpha Menu is a communications and writing system which offers a choice of inputs.

For people who cannot use a keyboard, the program displays a matrix of letters, numbers, and punctuation marks. The user chooses characters one at a time, constructing a sentence at the top of the screen. The text automatically "scrolls," or moves upward, as more lines of text are added. The text can be printed out separately.

Alpha Menu accepts any of three inputs: light pen, switch, and skate.

The light pen is a slim, lightweight pointer which mounts on a head or mouth stick. When the user touches the light pen against a character on the screen, the computer adds that character to the text at the top of the screen.

When Alpha Menu is accepting switch input, a pointer automatically steps down the screen, row by row. When the user activates the switch, the pointer begins moving across the screen, letter by letter. The user then re-activates the switch when the pointer reaches the correct letter. During operation, the system automatically adjusts the stepping rate of the pointer to the response time of the user. The switch input can be a button, a lever, a "sip and puff," or any other switch the user can operate.

With the skate controller, the user controls the position of the pointer directly, using either a joystick or a free-moving "bug."

Contact:

Bill James
5903 Danny Kaye
Box 3207
San Antonio, TX 78240
(512) 696-8750

Computer Speech

One communication system will actually speak out loud for people with speech disorders. The user types in a message up to 20 words long, drawing on a list of 5000 words in the computer's memory. When the user types a period at the end of the sentence, the system pronounces the words.

For people with minimal typing ability, only two letters need be typed. The system then displays a list of all the words in its memory starting with those two letters. In response, the user need only type the number of the desired word. This feature allows children to use words they can recognize but can't spell.

The program will also accept switch input from people who cannot use a keyboard.

The system produces only a male voice—the voice of its designer, Jay Hewitt. The pronunciations are stored on a Corvus hard disk instead of on the more standard (and less expensive) floppy disks. Because the hard disk costs about three times as much as the computer itself, the computer speech system is usually practical only for group applications, such as classrooms, where one disk can service many computers.

Contact:

Dr. Jay Hewitt
122 Queen's Place
Kansas City, MO 64131
(816) 942-6522

Part 2: Education

Help With Arithmetic

Many students with motor impairments have trouble learning math. The problem is not aptitude, but a physical inability to write out the complicated intermediate steps. Long division, for example, requires a series of intermediate multiplications, subtractions, and carries. People who cannot use a pencil have no way to perform these steps, short of keeping track of everything mentally. The result is that arithmetic skills are often not acquired by youngsters with motor impairments.

Dr. Jay Hewitt has developed a program that drills students in arithmetic problems and provides the tools to perform the intermediate calculations. All carries, multiplications, and subtractions take place on the CRT screen, under the student's control. The program will also accept a variety of inputs: keyboard, voice, sound, and switch.

Contact:

Dr. Jay Hewitt
122 Queen's Place
Kansas City, MO 64131
(816) 942-6522

Maplewood Center Project

The Maplewood Handicapped Children's Center in Edmonds School District, Washington, has integrated personal computers into its educational and therapeutic curricula for severely physically handicapped, non-vocal students.

Maplewood's communication disorders specialist and a consultant programmer have designed three sets of programs, including more than a dozen motor training games. The games programs let physically handicapped children learn to operate the computer with simple motor movements in a low-stress, high-reward situation. Since many of the children are not verbally oriented, the games use color, sound, and graphics.

Before choosing a control method for a student, the physical and occupational therapists carefully identify the most natural movements the child can use. As the students master the games, they move on to communication and academic programs.

The therapists can modify an Apple communication program for each child, using a text program to select the proper input controls, vocabulary, and speed. The children talk by choosing, from matrix

displays, words and phrases which can be accessed by one or two switches.

With the academic programs, students can perform intermediate- to junior-high-level work using only single-switch inputs. The educational programs include complex long division, addition, subtraction, and multiplication; plane geometry; math work problems; and various English drills.

Throughout the process, each student continues to receive physical therapy as well as motor and cognitive training on the computer. The programmer frequently observes the children using the equipment, so he can keep in touch with the needs of the students.

Contacts:

Judy McDonald
4614 First Avenue NE
Seattle, WA 98105
(206) 634-3211

Paul Schwejda
4529 Bagley Avenue N
Seattle, WA 98103
(206) 634-1877

Part 3: Games

For people with physical disabilities, computer games can be a lot more than entertainment. As the Glicksmans discovered, games develop both motor and social skills. At Maplewood, games have the dual job of training the students to use computers and allowing the therapists to assess which controls the students can use.

Learning to use a communication device can be very stressful for a child. The child must simultaneously master both new motor skills and the verbal skills necessary to communicate. By playing games at first, a child can develop the necessary motor abilities in a low-pressure situation, and then move on to communication programs.

Bill James has developed several games to teach children and newly disabled adults how to operate a computer:

Puff Ball allows the player to maneuver a ball through an obstacle course, using either a switch or a light pen. The speed of the ball and the difficulty of the course can be varied.

Plotto is used with a joystick or a bug, and allows the user to draw on the screen. The program can draw high-resolution graphics (fine lines) in black and white, or low-resolution graphics in color.

Chase is more a hand/eye coordination exercise than a game. The words "Tickle Me and I Jump" appear on the screen, and a white spot appears in a random position. When a light pen is touched to the spot, the spot blinks furiously, then jumps randomly to another place on the screen. After twenty jumps, the computer displays the average time taken to touch the spot after each jump.

Contact:

Bill James
5903 Danny Kaye
Box 3207
San Antonio, TX 78240
(512) 696-8750

Commercial games that have been adapted for use by the physically disabled are available from Jim Rogers in Birmingham, Alabama, and Gregg Vanderheiden at the Trace Center at the University of Wisconsin.

Contacts:

Jim Rogers
Cardiovascular Associates P.A.
1320 South 19th Street
Birmingham, AL 32505
(205) 933-2640

Gregg Vanderheiden
Trace Research & Development Center
University of Wisconsin
314 Waisman Center
Madison, WI 53706
(608) 262-6966

Applications For The Visually Impaired

Simon

Bill James has adapted the popular electronic game "Simon" for use by the visually impaired. Six special switches—activated by a hand-held magnet—are arranged in the Braille dot pattern. Each switch produces a different note of the major scale. During the game, the computer first plays a tune that varies from two to twelve notes in length, and from very slow to quite fast in tempo. The object is to reproduce the computer's tune. Since most legally blind people are partially sighted, a colorful display accompanies the music.

Contact:

Bill James
5903 Danny Kaye
Box 3207
San Antonio, TX 78240
(512) 696-8750

Braille On TV

This program is useful for teaching Braille to children with very little eyesight. The monitor displays large alphabetic characters and their equivalent Braille dot patterns. The computer can also sound the Morse Code signal for each letter as it appears.

Contact:

Bill James
5903 Danny Kaye
Box 3207
San Antonio, TX 78240
(512) 696-8750

Applications For The Hearing Impaired

The deaf community already uses teletypewriter devices to communicate over telephone lines. But without modification, these devices cannot access the new information networks now available to people with computer terminals. The problem lies in the difference between the encoding system used in teletypewriter machines and that used in modern computers. Standard teletypewriter devices use a system called "Baudot" to translate characters into electronic code which can be understood by the receiving machine. Personal computers use a different system, commonly called "ASCII."

Ted Perry has developed a package which allows an Apple personal computer to communicate with both Baudot and ASCII devices. With this system, a deaf person can hook up to computer information networks and still communicate with deaf people who use Baudot teletypewriters. The system includes translation programs for the Apple, and a specially built "black box" for sending and receiving Baudot code.

Perry's system has an "auto-answer" mode which answers the telephone in Baudot, sends out a message to the caller, and accepts a message response. It can also send out a specific stored message in response to a key word. For example, you could leave a message under the key word "Harry," in case your deaf friend Harry calls while you are out. When Harry calls and leaves his name, the system will send him the message.

The Amateur Radio Research and Development Corporation (Amrad) has developed a method of adapting the Apple for communication with Baudot teletypewriters. It accomplishes the ASCII/Baudot code conversion inside the Apple using a brief program. A small box connects the Apple's game socket to the modem for the teletypewriter.

Contact:

Ted Perry
Kyde Tyme Computer Project
San Juan Unified School District
6141 Sutter
Carmichael, CA 95608
(916) 944-3650

Paul Rinaldo
Amrad
1524 Springvale Avenue
McLean, VA 22101
(703) 356-8918

The Next Goal

All of these applications—with the exception of C2E2—are single, "dedicated" programs. For example, when the Microcommunicator is being used, it is the only program in the computer. In order to run Alpha Menu, the user has to physically remove the Microcommunicator diskette, replace it with the Alpha Menu diskette, and load the Alpha Menu program into the computer's memory. This disadvantage limits the value of these systems for people whose physical disabilities make it difficult to use a keyboard or handle a diskette.

C2E2 allows the user to change from one program to another without changing diskettes or memory data. But even C2E2 has the disadvantage of running only custom programs or custom-modified commercial programs.

The ideal computer system would run commercially available software without modifications. Researchers at the Trace Center in Madison, Wisconsin, are working towards such a system—a system which would allow users to choose from the hundreds of educational, business, and game programs currently available off-the-shelf at consumer prices. The users would not be limited to a few specially modified programs, nor would they have to pay the high prices of customized products.

Contact:

Gregg Vanderheiden
Trace Research & Development Center
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314 Waisman Center
Madison, WI 53706
(608) 262-6966

Bibliography

Apple Computer Clearinghouse for the Handicapped

A project of Prentke Romich Company, the clearinghouse includes a catalog summarizing programs developed for the handicapped. For more information, contact Prentke Romich Company, R.D. 2, Box 191, Shreve, Ohio 44676. The clearinghouse also develops custom hardware and software, and assembles and tests custom Apple systems.

Apple II—TRS-80 Microcomputer Report

Produced by the Trace Center, this report evaluates the Apple II and the TRS-80 microcomputers for applications in rehabilitation engineering.

Communication Outlook

This quarterly newsletter concentrates on the use of technology to offset communications handicaps. *Communication Outlook* is edited and published jointly by the Artificial Language Laboratory, at Michigan State University, and the Trace Center for the Severely Communicatively Handicapped, at the University of Wisconsin. *Communication Outlook* is considering the establishment of a software bank for the exchange of computer programs and other information. If you are interested in such a network, contact the editor of the publication, Yvonne Danjuma, at Michigan State University.

A Report on Microcomputers for Educational Users

Published by the Minnesota Educational Computing Consortium (MECC), this report surveys educational uses of computers. The publication is not aimed specifically at the disabled, but it can provide valuable insights. The report is available for $13.33 from MECC Instructional Services Division, 2520 Broadway Drive, Lauderdale, MN 55113.

Software Registry and Listing of Programs Adapted for Rehabilitation Applications With Microcomputers

From the Trace Center, this registry provides a cross-referenced listing of programs which have been written or adapted for use by individuals with physical handicaps. The listing includes a brief description of each program, the computer(s) it will run on, the memory requirements, the programming language, and the necessary peripherals. If you have developed an application, fill in the form on the back page and send it to Trace for entry into the data base.

Special Technology for Special Children: Computers to Serve Communication and Autonomy in the Education of Handicapped Children

By E. Paul Goldenberg, published by University Park Press, 233 E. Redwood St., Baltimore, MD 21202

Switch Inputs

A listing of different types of switches (joysticks, sip and puff, paddle, tip or tilt, foot, etc.), along with descriptions and names of manufacturers, is available from the Trace Center. The listing is a section in the Trace Center publication, "Non-Vocal Communication Resource Book." Most of these switches can be used with any application that accepts switch inputs.

Personal Contacts

Communication Outlook
Artificial Language Laboratory
Computer Science Department
Michigan State University
East Lansing, MI 48824
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TRACE SOFTWARE REGISTRY AND LISTING OF PROGRAMS ADAPTED FOR REHABILITATION APPLICATIONS WITH MICROCOMPUTERS

ENTRY FORM (Short Form for Software Listing)

PROGRAM NAME: _____
(26 characters)

DESCRIPTION: _____
(purpose)
(416 characters) _____

_____

_____

_____

_____

_____

_____

This registry/listing is a comprehensive compilation of microcomputer programs which are created or adapted for use in rehabilitation applications or for use by handicapped individuals. This is a computer data base listing, and is available either as a computer search or as a complete listing.

For more information, contact the Trace Center (address on reverse).

FORM AVAIL.: _____ _____
(26 characters) *(tape, disk, etc.)*

COST: _____
(25 characters)

MANUAL AVAIL. SEPARATELY: Y_____N_____ COST: _____

WRITTEN BY: _____
(25 characters)

ORDER FROM: _____ _____
(25 characters)

SORT NAME: _____
(8 characters) *(for Trace use only—leave blank)*

STREET: _____
(25 characters)

CITY: _____
(25 characters)

STATE: _____ ZIP CODE: _____
(2 characters) *(5 characters)*

PHONE: _____/ _____-_____
(10 characters; area code, number)

SORT CODES: _'_'_'_'_'_
(maximum of 6)
(see code explanation—over)

COMPUTER: _____
(20 characters)

MEMORY REQUIREMENTS: _____
(10 characters)

LANGUAGE: _____
(10 characters)

SOFTWARE REQUIREMENTS: _____
(DOS, special routines, etc.)
(60 characters)

STANDARD HARDWARE REQUIREMENTS: _____
(Disc, printer, etc.)
(100 characters) _____

_____

_____

CUSTOM HARDWARE: _____
(Describe)
(75 characters) _____

_____

AVAILABILITY OF CUSTOM HARDWARE: _____ (S,L,P,B,K,F)
(see code explanation)

DATE WRITTEN: _____/_____/_____ *(Month, Day, Year)*

DATE ENTERED: _____/_____/_____ *(Month, Day, Year)*
(for Trace use only— leave blank)

SORT CODE EXPLANATION

B	Business systems (other than writing/editing)
W	Writing/editing (includes typewriting and stationary communication aids)
K	Keyboard modifications, alternate keyboard and non-keyboard input routines
S	Speech (input or output)
P	Portable aids (battery operated; less than 25 pounds including battery)
I	Computer aided instruction
V	Visually impaired
H	Hearing impaired
T	Telephone communication
C	Control aids (including phone, self care, environmental control)
G	Games (for handicapped individuals)
A	Alarm, call, and monitoring systems (also reminder systems)
D	Drawing
E	Evaluation/testing
R	Robots (mobile)
M	Mobility
Q	Mentally retarded

AVAILABILITY CODE EXPLANATION

S	Schematics
L	Layout
P	Photoready layout
B	Printed circuit boards
K	Kit
F	Fully tested assembly

To return, fold this form into thirds, with address below facing out. Staple and mail in.
If questions, call Chris Thompson at 608/262-6966.

Trace Center
Attn: Chris Thompson
314 Waisman Center
1500 Highland Avenue
Madison, WI 53706